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भाग 1 धूल क्षरण

(पहला पुनरीक्षण)

Indian Standard

METHODS FOR MEASUREMENT OF AIR POLLUTION

PART 1 DUST FALL

(First Revision)

ICS 13.040.30

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

May 2006 **Price Group 3**

Environment Protection and Waste Management Sectional Committee, CHD 32

FOREWORD

This Indian Standard (Part 1) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Environment Protection and Waste Management Sectional Committee had been approved by the Chemical Division Council.

The precise measurement of solid material deposited at any particular site is difficult and it should be noted that the amount collected and retained in a collector is influenced by factors, such as the height of the collector above ground, the nature of the site and the meteorological conditions, for example wind force and rain fall. These factors have to be kept in mind when any comparison is made of the quantity of deposit measured at different sites, or even at the same site under varying weather conditions but such comparisons may be valid in relation to known circumstances, specially when results are averaged over several months.

When a collector is suitably sited, the observed amount of deposition can reasonably be regarded as being representative of a larger area than that actually covered by the collector. The period of exposure is commonly called a calendar month, but this is a variable number of days and, for purposes of comparison, the results may be suitably expressed in terms of the average daily rate of deposition.

The standard was first published in 1969 under a series of standard methods of measurement of air pollution taking considerable assistance from BS 1747 : Part 1 : 1961 'Methods for the measurement of air pollution — Part 1 Specification for deposit gauges'. Based on the last three decades experience and technological development on the analytical procedures the concerned Committee decided to revise the standard.

There is no ISO Standard on the subject. This standard is prepared based on the measuring techniques available and use in India.

The composition of the Committee responsible for formulation of this standard is given at Annex A.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

METHODS FOR MEASUREMENT OF AIR POLLUTION

PART 1 DUST FALL

(First Revision)

1 SCOPE

1.1 This standard (Part 1) prescribes a method for the collection and measurement of dust fall rates.

1.2 Other Analysis

Soluble and insoluble deposits are subjected to analysis for ions, elements, inorganic and organic compounds. These additional analysis have been used in source apportionment studies.

2 REFERENCES

The standards listed below contain provisions which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
1070 : 1992	Reagent grade water (*third revision*)
4167 : 1980	Glossary of terms relating to air pollution (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definition given in IS 4167 shall apply.

4 FIELD OF APPLICATION

This method is applicable to area surveys for determining particle fallout nuisances and has been adapted to the measurement of wet and dry deposition.

For a month-long sample duration, the lower quantifiable limit is determined by the reproducibility of the filter and drying crucible weight differences. These exhibit standard deviations (sigma) of approximately ± 2 mg. The three-sigma lower quantifiable limit for a container with a 125 cm^2 collection area is then approximately 0.35 g/m^2 mo. For a month-long sample duration there is practically no upper quantifiable limit unless the capacity of the particle fallout container is exceeded.

5 INTERFERENCES

5.1 Bird droppings, insects, algae, fungi and large plant material are not considered to be a portion of particle fallout. Bird droppings are minimized by a bird ring. Fungicides and algaecides can be added to the container collection solution. Particles larger than 1 mm diameter are removed by sieving.

5.2 Soluble Gases

Gases can be dissolved by the container solution and may manifest themselves as soluble particulate matter. This interference will be negligible for mass concentrations but may bias measurements of particulate chemical species.

5.3 Wind Speed

The sampling efficiency of cylindrical containers has been shown to be nearly zero for wind speeds of greater than 7 m/s for particles of the order of 100 µm diameter. The efficiency is approximately 60 percent for 100 µm particles in 1 m/s winds. Alternative container designs have been proposed to minimize this interference.

5.4 Particle Blowout

Dry particles collected in a container can be re-suspended by wind with subsequent removal. A quantity of water in the container minimizes these intereferences.

5.5 Leacher to Container Surfaces

Certain metal ions have been found to leach into various materials when in solution. This interference is negligible for soluble mass measurements, but it may affect the concentrations of various chemical species.

5.6 Leaching from Container Surfaces

Contaminants on the surface of the collection container will be measured as particle fallout. Rinsing of containers prior to use will minimize this interference.

6 APPARATUS

6.1 Particle Fallout Collector — A cylindrical container is located on a stand at least 1.2 m from the support surface. A bird ring extends above the rim of the container to prevent birds from perching on the container. Container can be made of glass, plastic, or stainless steel, should have a circular opening of greater than 15 cm diameter, and should have a length of two to three times this diameter. Figure 1 shows the collector configuration.

6.2 Sieve — Stainless steel sieve No. 18 (1 mm mesh) to be used to remove large particles from the sample.

6.3 Crucibles — Non-porous ceramic or glass crucibles, 50 to 100 ml to be used for evaporation of soluble species in determining soluble particle fallout.

6.4 Filter Unit or Filter Funnel — A 200 ml or larger filter funnel capable of accepting a 47 mm or larger filter to be used for separating soluble from insoluble particles. Either gravity or a vacuum assist can be used to draw the solute through the filter.

6.5 Angle-Edged Rubber Spatula — The spatula (sometimes called a policeman) to be used to remove deposits that adhere to the sides and bottoms of the container.

6.6 Analytical Balance — A balance with the sensitivity of 0.1 mg and a range adequate for weighing of both crucibles and filters. Class S weights shall be used for calibration.

6.7 Laboratory Oven — An oven suitable to evaporate water from a portion of the filtered liquid placed in a crucible, by maintaining the temperature at 105 ± 1°C.

6.8 Graduated Cylinder — The graduated cylinder, 1 litre capacity is used to determine the volume of liquid in the container.

NOTE — An alternative to this method involves weighing the container before and after sampling and equating the change in mass to the liquid volume.

6.9 Filter — A quartz or glass fiber filter is most appropriate for the removal of solid particulate matter. Chemical analysis of particles deposited on the filter may require other types or media.

7 REAGENTS AND SUPPLIES

7.1 Water — Reagent grade water conforming to IS 1070 shall be used.

7.2 Algicide and Fungicide — Copper sulfate will inhibit the growth of algae. Mercuric chloride will inhibit the growth of both algae and fungi, but it is toxic. One-tenth of a gram (sufficient to provide a concentration of 15 mg/l when the container is full) of these reagents should be sufficient. These reagents should be fully dissolved in the collection fluid and should never attain concentration levels, which would cause them to precipitate and be mistaken for insoluble particles.

NOTE — These reagents should only be added if algae and fungi growth have been observed when no chemicals are added.

7.3 Anti-freeze (Isopropyl Alcohol) — Anti-freeze may be added to reduce the freezing temperature of the water.

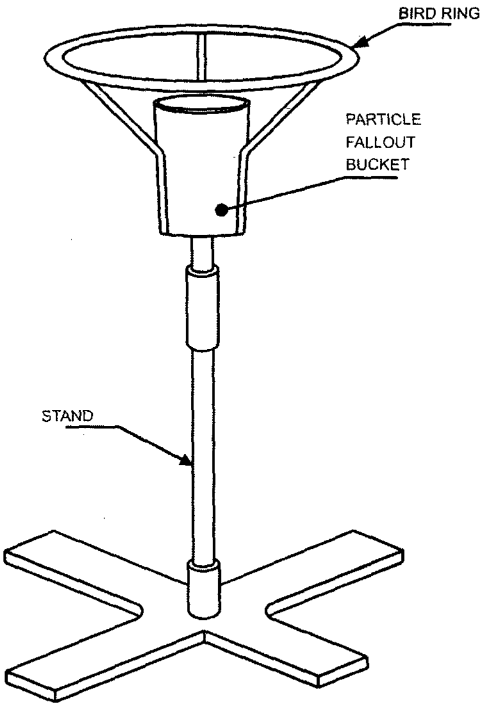

FIG.1 PARTICLE FALLOUT MEASUREMENT APPARATUS

This is necessary only when temperature is expected to fall below 0°C. A 50 percent solution is usually adequate, though higher proportions of anti-freeze may be necessary in colder climates or ones with higher precipitation levels.

8 PROCEDURE

8.1 Figure 2 presents a flow diagram of the routine operating procedures described in the following sub-section.

Wash dust fall storage container with distilled water and send to field for sample collection.

↓

Install dust fall container in sampling stand. Add water, algaecide, and fungicide, if required. Record sample ID, sampling time, and volume of added liquid and forward these information's to laboratory on data sheet. Leave container for 1 month and bring it back to lab after noting removal time to laboratory on completion of sample collection. Record removal date and time on data sheet.

↓

Dry and weigh fiber filter. Pour container contents through sieve and filter. Dry and weigh filter. Quality control includes zero/span verification every ten samples and re-weights 1 out of 10 samples. Record filter weight gain and volume of filtered liquid.

↓

Dry and weigh crucible. Transfer 100 ml of filtered liquid to the crucible and evaporate in a drying oven. Weigh the dried crucible. Quality control includes zero/span verification every ten weights and re-weights of 1 out of 10 samples. Record crucible weight gain and volume of evaporated liquid.

↓

Calculate insoluble, soluble and total dust fall rates as shown in calculations.

FIG. 2 FLOW DIAGRAM FOR THE ROUTINE DUST FALL OUT MEASUREMENT

8.2 Sampler Sitting

A sufficient number of sampling sites shall be chosen to obtain representative samples of an area under study. An initial survey with many sampling sites may be conducted to determine whether or not a smaller number of sites is adequate. A minimum of four stations is considered necessary to be representative. Each sampling site needs to be located at least 100 m away from fugitive dust area sources and major point sources. The rim of the container shall be between 2.4 m and 15 m above ground level and at least 1.3 m above the supporting surface. The top of any nearby obstruction shall not exceed a line which is 30° from horizontal at the height of the container opening.

8.3 Container Preparation

Thoroughly wash the container with soap and water with final rinse with reagent grade water prior to sample collection. Cover the container before transporting it to the field to protect it from contamination.

8.4 Field Sampling

Place the container on the stand and remove the cover. Place the cover in a protective bag and store it until the container is retrieved from the field. Pour 0.2 to 1.0 litre of water (which may contain algicide or anti-freeze as specified in **7.2** and **7.3**) into the container. The amount of this liquid should be sufficient to prevent evaporation through out the sampling period, but not so much that the container will overflow after receiving a normal amount of precipitation. Measure this volume of liquid with a graduated cylinder and record it on the identification label. It is often convenient to pre-measure this liquid in the laboratory and to transport it to the field in a reagent bottle. Put identification label on the side of the container and assign an identification number to the sample. Note the sampling site, date, and start time of dust fall sampling on the label. The standard sampling duration is 30 ± 2 days. After completion of the sampling period, note the removal date and time on the identification label. Record any observations, such as nearby emissions activities, the presence of insects, bird droppings, or other unusual material in the container, algae formation, and freezing, on the label. Securely place the lid on the container and return it to the laboratory.

8.5 Laboratory Analysis

8.5.1 *Filtration and Volumetric Measurement*

Dry a quartz or glass fiber filter in the oven at approximately 105 ± 2°C overnight and weigh it on the analytical balance. Place it in the filtration funnel or filter unit. Channel the liquid exiting the filtration unit into a graduated cylinder. Carefully pour the liquid in the container through the No.18 sieve and into the filtration unit. If the container contains less than 0.2 litre of liquid, add some amount of deionized distilled water and mix it thoroughly with the contents of the container. When the container has been emptied of all liquid, record the volume collected in the graduated cylinder on the data label. Scrape the wall of the container with a clean rubber spatula while rinsing them with water. Filter this liquid until no visible signs of dust remain the container. If the volume of liquid collected is to be determined gravimetrically, weigh the full container with its lid removed both before and after the filtration process.

8.5.2 *Insoluble Dust Fall Measurement*

Dry the filter in the over for at least 2 h at 105 ± 2°C. Re-weigh the filter on the analytical balance and calculate the increase in mass resulting from the filtration process.

8.5.3 *Soluble Dust Fall Measurement*

Weigh a clean crucible on the analytical balance. Transfer 25 to 100 ml of the filtered liquid from the graduated cylinder to the crucible. Heat this liquid in the over at 105 ± 2°C for a sufficient period of time to evaporate all of the liquid. Re-weigh the crucible up to constant weigh and calculate the increase in mass attributable to soluble species. Record the volume of liquid evaporated on the identification label.

8.6 Maintenance

No additional maintenance is required other than that already specified in the procedures.

8.7 Replicates

Re-weigh one out of ten filters or crucibles. These replicate analysis are used to calculate propagated precisions of the measurements.

8.8 Calibration

8.8.1 *Gravimetric Analysis*

Place a 3 g weight on the analytical balance prior to and after each weighing session and verify the balance calibration to within ±0.1 mg. The balance shall be serviced and recalibrated if this tolerance is not met.

8.8.2 *Volumetric Measurements*

Scales on graduated cylinders shall be verified upon receipt by weighing them before and after filling to a desired level with deionized distilled water. The increase in weight in grams shall equal to the number of millilitres to within ± 2 percent.

9 CALCULATIONS

9.1 Calculation of Insoluble Particle Fallout Rate

Insoluble particle fallout rate, g/m^2 mo;

$$C_u = \frac{(M_{fu} - M_{iu})}{AT}$$

where

A = area of particle fallout container opening, in m^2;

T = sampling duration, 30-dmo;

M_{iu} = weight of blank filter; in g; and

M_{fu} = weight of loaded filter; in g.

9.2 Calculation of Soluble Particle Fallout Rate

Soluble particle fallout rate, g/m^2 mo,

$$C_s = \frac{(M_{fs} - M_{is})}{AT} \quad \frac{V_1}{V_2}$$

where

M_{is} = weight of blank crucible, in g;

M_{fs} = weight of loaded crucible, in g;

A = area of particle fallout container opening, in m^2;

T = sampling duration, 30-dmo;

V_1 = volume of all liquid collected, in litre; and

V_2 = volume of liquid removed for evaporation, in litre.

9.3 Calculation of Total Particle Fallout Rate

C_t = total particle fallout rate, g/m^2 mo,

$$C_t = C_u + C_s$$

where

C_u = insoluble particle fallout rate, g/m^{2}mo; and

C_s = soluble particle fallout rate; g/m^{2}mo.

9.4 Sample Validation

Samples are invalidated when large quantities of wind-blown garbage, insects, and bird droppings are observed in the container liquid.

10 PRECISION AND ACCURACY

10.1 Precision

Inter-comparison studies in different urban areas have found average collocated precisions (one sigma) of 1.46 µg/m^2 mo among different laboratories and average collocated precisions of 1.03 g/m^2 mo within the same laboratory for total dust fall. This precisions appears to be independent of the range of dust fall rates measured between 3 and 11 g/m^2 mo. For the water-insoluble fraction, the inter laboratory average standard deviation was 1.8 g/m^2 mo and the within laboratory average standard deviation was 0.78 g/m^2 mo. For the water-soluble fraction, the between-laboratory average standard deviation was 1.64 g/m^2 mo and the within laboratory average standard deviation was 0.59 g/m^2 mo.

10.2 Accuracy

Inter laboratory analyses of samples spiked with known quantities of salt, sand, and granular polystyrene yielded average recoveries of 96 ± 16 percent for total dust fall and 91 ± 18 percent for insoluble dust fall.

11 EFFECTS OF SAMPLE STORAGE

Algae and other biological material may grow in containers which are stored for long periods of time. Soluble species may leach from or adhere to the container surface. Samples should be analyzed as soon as possible following collection.

ANNEX A
(Foreword)

COMMITTEE COMPOSITION

Environment Protection and Waste Management Sectional Committee, CHD 32

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In personal capacity (*40/14, C.R. Park, New Delhi-110019*)	Prof Dilip Biswas (***Chairman***)
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